

# VLBI Data Analysis - Who Does What.

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Durga Bagri	VLBI Hardware	<a href="mailto:Durgadas.Bagri@jpl.nasa.gov">Durgadas.Bagri@jpl.nasa.gov</a>
Jim Border	Delta DOR	<a href="mailto:James.Border@jpl.nasa.gov">James.Border@jpl.nasa.gov</a>
Chris Jacobs	Task Leader - Catalog	<a href="mailto:Christopher.S.Jacobs@jpl.nasa.gov">Christopher.S.Jacobs@jpl.nasa.gov</a>
Gabor Lanyi	Catalog, TEMPO, Delta DOR	<a href="mailto:Gabor.E.Lanyi@jpl.nasa.gov">Gabor.E.Lanyi@jpl.nasa.gov</a>
Chuck Naudet	VLBI Hardware	<a href="mailto:Charles.J.Naudet@jpl.nasa.gov">Charles.J.Naudet@jpl.nasa.gov</a>
George Resch	Group Supervisor	<a href="mailto:George.M.Resch@jpl.nasa.gov">George.M.Resch@jpl.nasa.gov</a>
Ojars Sovers	(at RSA), MODEST	<a href="mailto:ojars@rsasys.com">ojars@rsasys.com</a>
Alan Steppe	TEMPO	<a href="mailto:James.A.Steppe@jpl.nasa.gov">James.A.Steppe@jpl.nasa.gov</a>
L. D. Zhang	Catalog, TEMPO	<a href="mailto:L.D.Zhang@jpl.nasa.gov">L.D.Zhang@jpl.nasa.gov</a>
	also	
Steve Lowe	VLBI Software - FIT, SoftC	<a href="mailto:Stephen.T.Lowe@jpl.nasa.gov">Stephen.T.Lowe@jpl.nasa.gov</a>

# Introduction

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- **Spacecraft Navigation**
  - Differential VLBI for Spacecraft Navigation
- **Mark IV VLBI**
  - Reference Frame, Earth Orientation, and other
- **Research & Development**
  - Wet Trop Calibration (WVR), Ka Band VLBI
- **Conclusion**

# Spacecraft Navigation - Differential VLBI

- Differential Spacecraft-Quasar VLBI

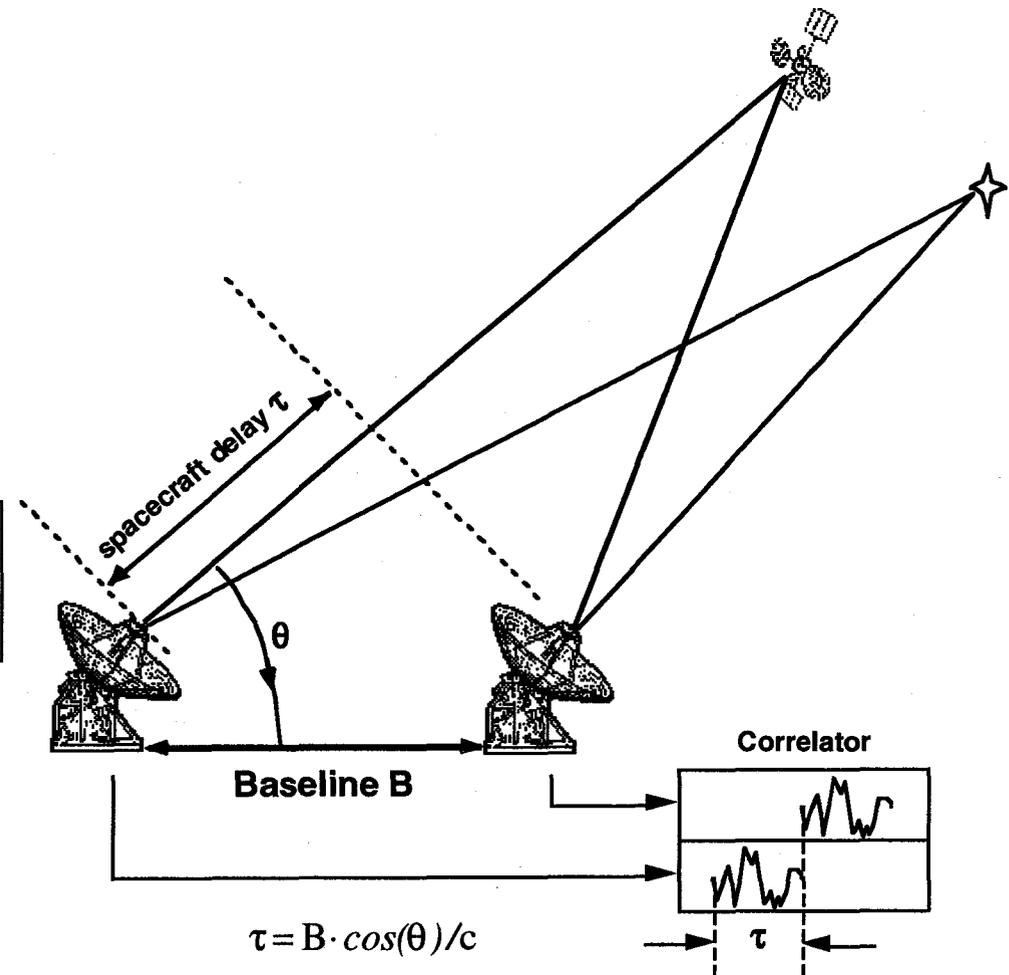
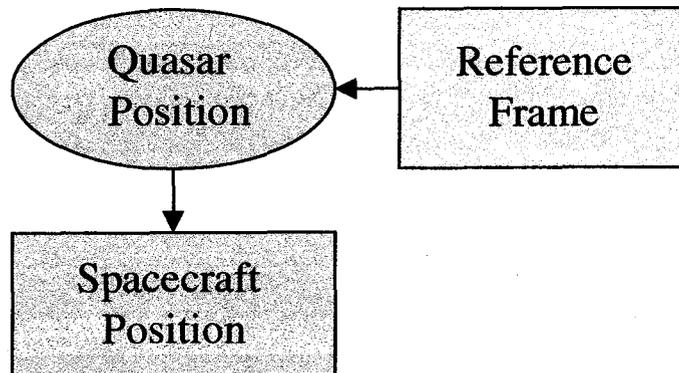
- Motivations

- JPL Deep Space Missions

- Technique

- Interferometer Delay

- 1. Spacecraft
    - 2. Nearby Quasars ( $< 15^\circ$ )



# Spacecraft Navigation - Differential VLBI

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## - System Profile

Radio Science Receiver (RSR) - JPL  
10 - 40 MHz Bandwidth ~ a tenth of Mk IV  
Network Transmission of Data to JPL  
Software Correlator  
Delay Residuals < 200 ~ 500 ps  
Angular Accuracy < 7.5 - 15 nrad

## - Software Correlator

Minimum Replication Costs  
Reduced Maintenance  
“Free” Speed Up with New Computers

# Spacecraft Navigation - Software Correlator

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- Software Correlator
  - C code runs on VMS and Unix
  - Fringes already found
  - Testing underway
  - Planned for use with Mars'01 Navigation
  - Current 6 Mbits/sec realtime per 500 MHz CPU

Feb 06 2001

# JPL VLBI Program - Summary

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- **Radio Reference Frame**
  - Observations
    - 8 sessions/yr, 24 hr/session, intercontinental baselines, 20 yr. database
  - Diagnostics -(what does this mean????)
  - Analysis
    - Reference Frame, Station Locations, Earth Orientation, Precession/Nutation
- **Earth Orientation VLBI - Support JPL Spacecraft Navigation**
  - Semi-monthly VLBI Calibrations of Daily GPS (UT1-UTC)
    - California-Spain Baseline - 8000 km
- **MODEST**
  - Source Structure Modeling
- **Other Users**
  - Space VLBI, EVN, GSFC Geodynamics, Host Country

# Mark IV VLBI - Future Prospects

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- **Reference Frame**
  - Limited by Systematic Errors, not by SNR
  - Prospects of Reducing Systematic Errors
    1. Wet Troposphere Calibration
      - The dominant error source ( < ~ 30 ps delay residual)
    2. Instrumentation Improvement
      - Frequency distribution, Phase cal, Fiber optic cable
    3. Source structure modeling
      - Implementing source structure modeling
- **Earth Orientation**
  - Prospects for Improved Operation
    - Desire 1 day turn around
    - Network Transmission of Data
    - Implement Software Correlator

# R & D - Wet Trop Calibrations

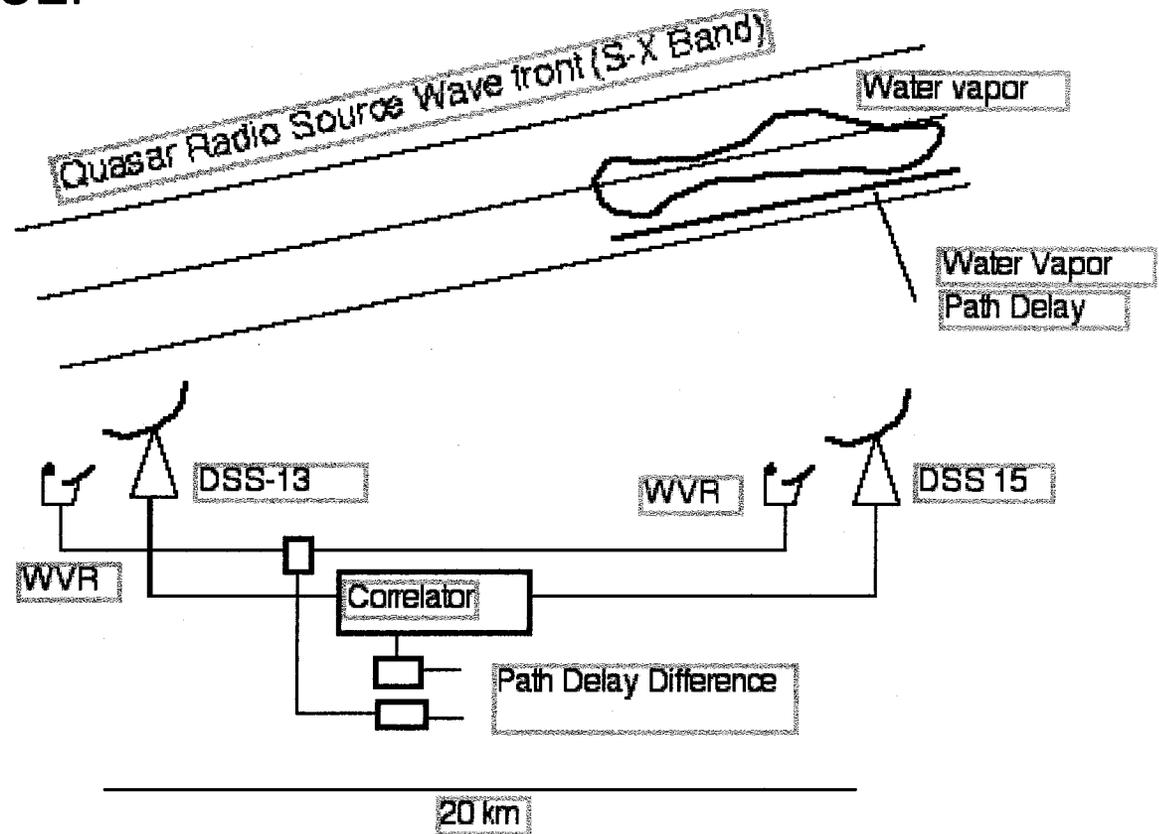
- Wet Trop Delay Calibration

- \* New WVR Features

- Gain Stability, Narrow Beam  $1^\circ$  (was  $7^\circ$ )

- \* Configuration: WVR-CEI

- 20 km Baseline
    - Connected Element Interferometer - CEI
    - Geophysical Advantage
      - Only Geometric Delay
    - WVR Antenna Co-Point

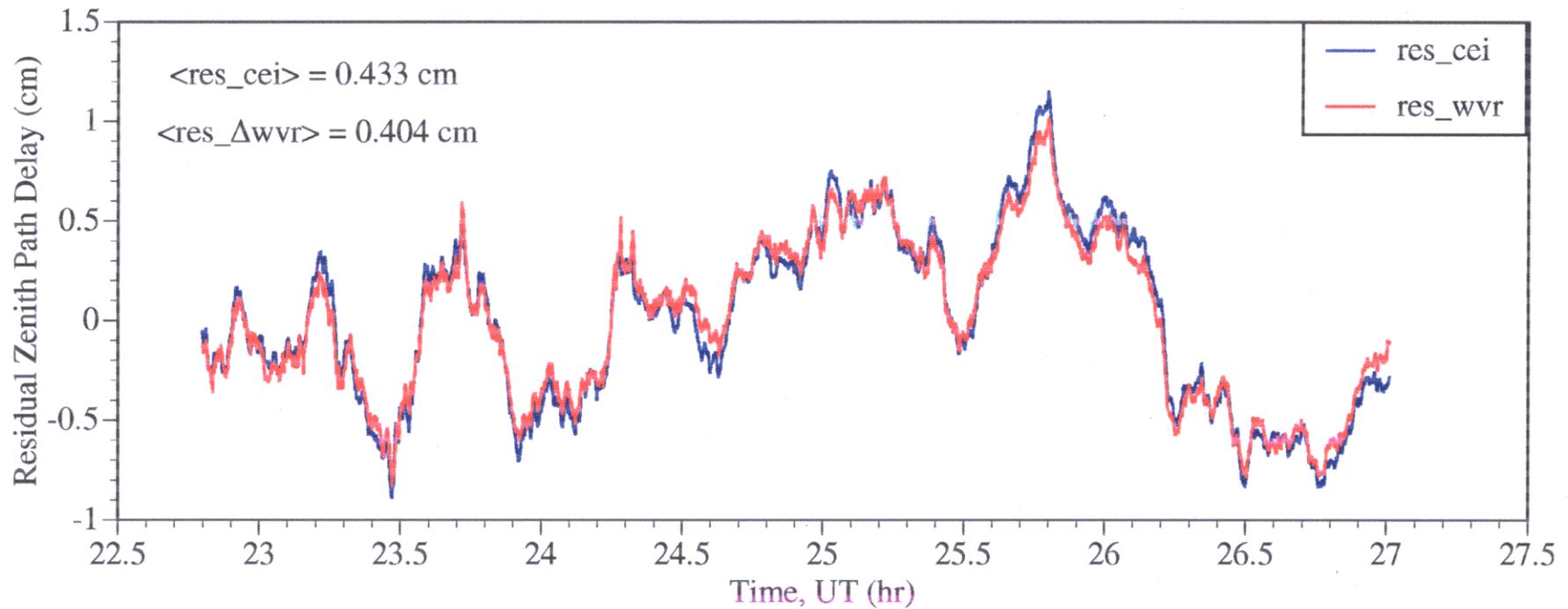


# R & D - Wet Trop Calibration



- WVR-CEI Results

18May 2000, DSS13/15 @ X-Band - Source = DA193



# Conclusion

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- **Spacecraft Navigation**
  - Implement Differential VLBI for Mars'01 Navigation
  - Software Correlator - New
- **Mark IV VLBI**
  - Reference Frame, Earth Orientation, MODEST
  - Future: Trop-Cal, Instrumentation, SoftCorr, Modeling
- **R & D**
  - WVR Results Can Significantly Reduce Systematic Error
  - Prospects of Ka Band VLBI